Copper Infiltration of Steel: Properties and Applications

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Part 1. Properties of Copper Infiltrated Steel

Copper infiltration of P/M steels has been in use for some 40 years. One of the main features of the process is the economical achievement of attractive mechanical properties. Nevertheless, while infiltration with copper improves both tensile and impact properties, the absolute values for impact energy still are rather low.

During the past 20 years developments which have affected the copper infiltration of P/M steels include the use of higher starting densities, the introduction of low alloy steels, and the increasing use of nitrogen-base sintering atmospheres. The availability of high compressibility powders in the early sixties shifted the starting densities for copper infiltration to higher values providing an increase in both tensile and impact properties with savings in copper infiltrant consumption. Figure 1 shows Charpy unnotched impact energies of uninfiltrated sintered steels for medium compressibility sponge iron (MH-100) and high compressibility water atomized Ancorsteel 1000. Figure 2 shows published values of ultimate tensile strength, impact energy, and elongation of infiltrated steel as function of uninfiltrated density. Carbon content of the green steel parts was 0.9%. Infiltrated density was 7.4 g/cm^3. The values shown in Figure 3 and Table I are taken from published data[1-7] for pressed and sintered steels and for infiltrated carbon and low alloy steels, both in the as-sintered and heat-treated conditions. Despite the low levels for impact energy, the attractiveness of copper infiltration is clear, particularly if the infiltration process can be exploited to yield some of the additional benefits listed at the beginning of Part II of this paper. With the more costly techniques of repressing and powder forging, significantly higher values of impact energy are achieved for a given level of tensile strength (see Table II)[1,7,8]. With powder forging it is possible to obtain strength levels equal to wrought materials.

The relatively low impact energy and ductility values of copper infiltrated steels have been attributed to residual porosity[8] and the large strength differences between steel and copper matrix. Even high density commercial copper